29 Metals

Gossan Valley – Application for Works Approval

Attachment 8 – Supporting Information

Golden Grove Operations Pty Ltd

Table of Contents

FIGURES

TABLES

1. Introduction

1.1. Overview

The Gossan Valley (GV), Grassi and Felix base metal deposits (collectively the Gossan Valley Project) were first discovered in 1971 and lie wholly within mining lease tenement M59/92. The Gossan Valley Project (GVP) is located approximately 7 km south of Gossan Hill mine (Figure 1-1), with the intention for the Project to maximise the use of existing infrastructure to support mining this underground deposit.

Limited exploration of the GVP mineralisation was conducted up until 2010, after which several diamond hole drilling programs were commissioned. A summary of the exploration history for the period 2010-2020 is detailed below:

- 2010: 90 holes drilled at GV for resource modelling;
- 2013-2017: 35 diamond holes drilled at GV and Felix for resource extension and modelling;
- 2018-2019: 103 diamond holes drilled at GV, Felix and Grassi for resource modelling; and
- 2020: 32 diamond holes drilled at GV and Grassi for resource extension and modelling.

The GVP is expected to have a nominal eight-year mine life (with extensions possible depending on resource growth and meeting economic hurdles), producing a steady rate of 0.5 Mtpa, totalling 4.1 Mt of ore over the life of mine (LOM). The mine will operate 24 hours a day, seven days a week.

The ore will be accessed via an underground mine, with the primary mining method being longhole stoping with some cemented rockfill. Safe access to the underground mine will be via a box-cut, 36 m in depth and located in proximity to the planned surface and underground infrastructure with consideration of where the fresh rock horizon is nearest to the surface.

A surface run-of-mine (ROM or mine-ore-pad (MOP)) will be established in close proximity to the box-cut. With the potential for the mined ore to be potentially acid forming (PAF), the MOP will have a sub-base incorporating an impermeable clay layer and a trafficable rock layer graded towards a spoon drain. The spoon drain will feed into a catchment dam where surface runoff will be contained. Trucks will haul all ore from the underground mine and dump at this location. From the GV MOP, ore will be hauled to the Gossan Hill MOP using road trains, where it will then be transported via the existing overland conveyor to the Scuddles processing facility.

A waste rock dump (WRD) will be constructed from the waste generated from the underground mine with a 1.6 Mt capacity. The WRD will be located on the western side of the main infrastructure, near the existing topographic hillside. The WRD will be rehabilitated such that it will not be higher than the existing, natural topography. Development waste material from the GVP has been characterised as non-acid-forming (NAF), however, mineralised waste (nominally 8% of total waste material) is PAF. Any PAF material will be placed in the centre of the WRD footprint and encapsulated with fresh rock from underground mining. An underdrainage system and shallow monitoring bores will be installed to manage PAF material. Surplus oxide materials from the box-cut construction will be used to cap the profiled fresh rock as part of the rehabilitation process.

Dewatering from underground mining will be pumped to a settling dam, compartmentalised into two sections with a connecting spillway. Sediment laden dewatering water will be pumped into the ‘inflow dam’ where it will be allowed to settle and the sediment free water left to overflow across the spillway into the ‘outflow dam’. Water from the outflow dam will be reticulated to relevant areas, as required – back to the underground, workshop/washdown pad and to the processing plant. The dams will be HDPE lined to prevent seepage.

Support infrastructure is required to allow the Project to function as a stand-alone operation. This will involve the extension of existing facilities, such as high voltage power supply, pipelines and roads, and the establishment of new infrastructure. The proposed new infrastructure includes, but is not limited to:

- Workshops and laydowns;
- Plant site for a concrete batch plant and power;
- Ventilation rises and escapeways;
- Landfill;
- Explosives magazine;
- Water tanks, air compressors, generators;
- Offices, crib rooms, etc.; and
- Fuel facility.

As part of all construction activities, dedicated topsoil stockpiles will be created to allow for the material to be reclaimed for future rehabilitation purposes. Locations will be determined based on ease of access for future reclamation.

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Mount Magnet
Geraldton-Mount Magnet Rd
Yalgoo
Geraldton-Mount Magnet Rd
Barrabarra Nature Reserve
Barnaboinnah Conservation Park
Gossan Valley Mine Site
Thundelarra Conservation Park
Mungada Ridge
Morawa
Bowgarder Nature Reserve
Great Northern Hwy
LAKE MOORE
Perenjori

Data source: Roads, Rail, Watercourses - Landgate 2023; Lakes - Geoscience Australia, 2024; Legislated Lands & Waters - DBCA, 2023; Minedex - DMIRS, 2023; Imagery: ESRI, 2023.

LEGEND

- Mine Site

Hydrology
- Major River
- Minor River
- Lakes

Legislated Lands and Waters
- Conservation Park
- National Park
- Nature Reserve
- Timber Reserve

Rail Network
- Railway Stations
- Railway Lines

Western Australian Roads
- Freeway / Highway
- Main Road

LOCALITY

0 1,000 2,000 3,000 4,000 5,000 km

SITE LOCALITY

Golden Grove
Gossan Valley Mine Site

Works Approval

29Metals

0 5 10 15 20 25 30 km

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:780,000

Prepared:	E Jackson	Date:	14/02/2024
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

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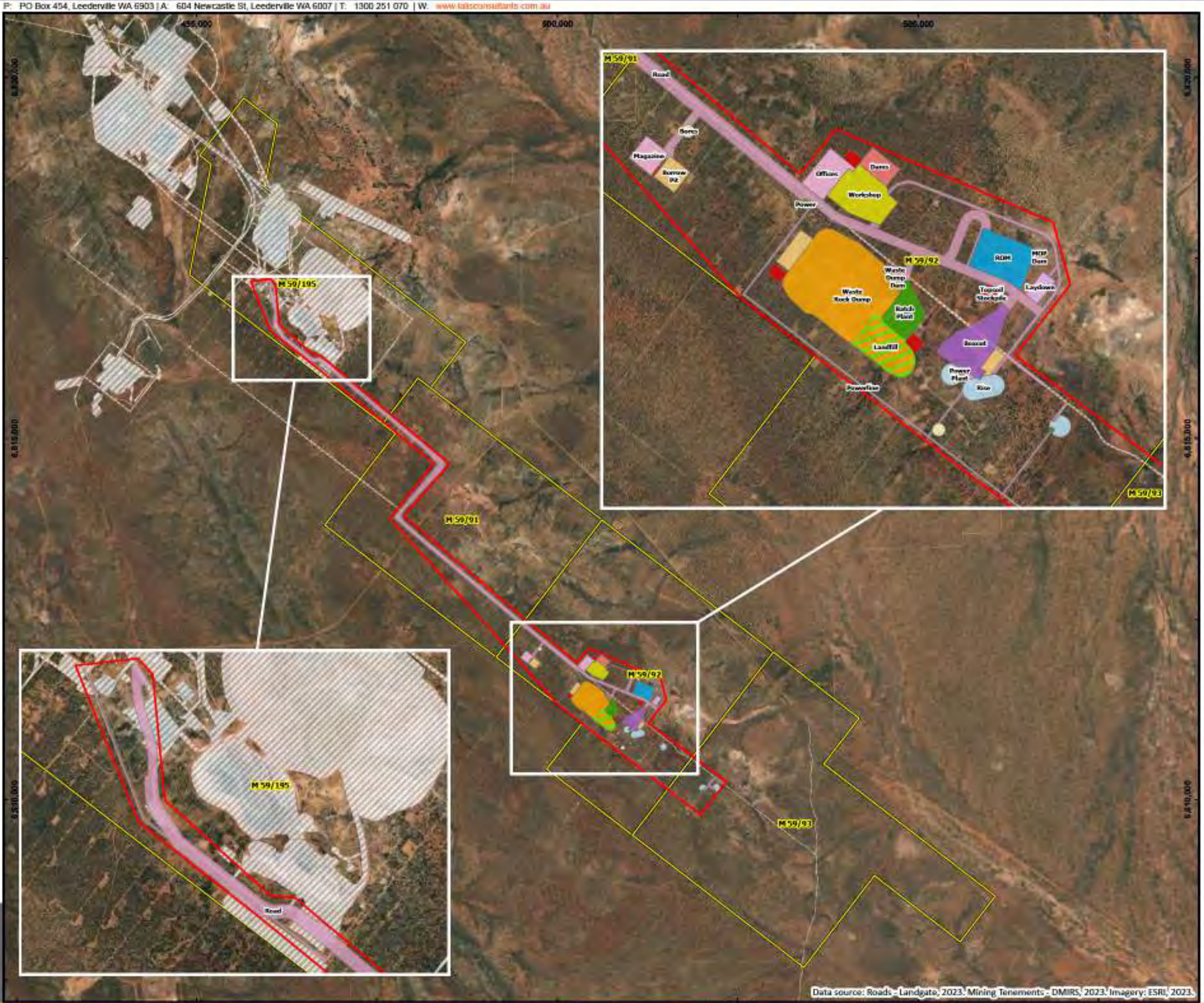
29 Metals — Golden Grove

Figure 1-1



LEGEND

- Disturbance Envelope
- Mining Tenements
- Existing Disturbance Footprint - Golden Grove

Site Layout

- Borefield
- Borrow Pit or Shallow Surface Excavation (with a depth of less than 5m)
- Building (other than Workshop) or Camp Site
- Dam: Saline Water or Process Liquor
- Land (other than land under rehabilitation or rehabilitated land) that is cleared of vegetation and not otherwise described in this table
- Landfill Site
- Laydown or Hardstand Area
- Mining Void (with a depth of at least 5 metres) - Below Ground Water Level
- Plant Site
- Run-of-Mine (ROM) Pad
- Topsoil Stockpile
- Transport or Service Infrastructure Corridor
- Waste Dump or Overburden Stockpile (Class 1)
- Workshop

LOCALITY

MINE DISTURBANCE ENVELOPE

Golden Grove
Gossan Valley Mine Site

Works Approval

29Metals

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:50,000

Prepared: E Jackson	Date: 9/02/2024
Reviewed: J Kirke	Revision: A
Project: TE23057	

Golden Grove

Figure 1-2

2. Project Description

A Works Approval (WA) is required for the construction of the supporting infrastructure necessary for the mining operations at Gossan Valley, specifically mine dewatering associated infrastructure and a landfill. The proposed Prescribed Premise boundary for the WA application will align with the boundary for tenement M59/92 (Figure 2-1), a total area of 839.85 ha. Any proposed clearing required for the works presented in this application will be undertaken under the approved clearing permit CPS 9046/1.

The categories for each of the Prescribed Premises being applied for are presented in Table 2-1.

Table 2-1: Prescribed Premises Details

Classification of Premises	Prescribed Premises Description	Production or design capacity
Category 6	Mine Dewatering: premises on which water is extracted and discharged into the environment to allow mining of ore.	750,000 tonnes per annum
Category 63	Class I inert landfill site: premises (other than clean fill premises) on which waste of a type permitted for disposal for this category of prescribed premises, in accordance with the *Landfill Waste Classification and Waste Definitions 1996*, is accepted for burial.	5,000 tonnes per annum

A schedule of the proposed construction, commissioning and time limited operations timeframe is provided in Table 2-2.There will be staged construction for each of the infrastructure items listed in **Table 2-2**.

Table 2-2: Proposed Works Schedule

Infrastructure	Construction	Commissioning	Time Limited Operations
Dewatering 'inflow' and 'outflow' dams	September 2024 – August 2025	Report required	180 days
Dewatering pipeline	September 2024 – August 2025	N/A	180 days
Bores	September 2024 – August 2025	N/A	180 days
Landfill	February 2025 – May 2025	N/A	180 days

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499,000 500,000 501,000 502,000 503,000

6,814,000 6,813,000 6,812,000 6,811,000 6,810,000

Pipeline & Transport Corridor

GVW005P

Inflow / Outflow Dam

Landfill

GVW007P

Data source: Roads - Landgate, 2023. Imagery: ESRI, 2023.

LEGEND

Prescribed Premises Boundary

Site Layout

- Borefield
- Dam: Saline Water or Process Liquor
- Landfill Site
- Transport or Service Infrastructure Corridor
- Proposed Infrastructure

LOCALITY

0 100 200 300 400 500 km

MINE DISTURBANCE ENVELOPE

Golden Grove
Gossan Valley Mine Site

Works Approval

29Metals

0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:18,000

Prepared:	E Jackson	Date:	9/02/2024
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

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29 Metals Golden Grove

Figure 2-1

2.1. Dewatering 'inflow' and 'outflow' dam

Two dams ('Inflow' and 'Outflow') will be constructed in the northwest corner of the Project. The location for the dams has been chosen based on the intended use of the water for reticulation through the workshop and washdown pad, and back underground. The area also has the benefit of being in proximity to power.

Each dam will be 60 m x 60 m in dimension with an internal batter of 45º, resulting in a total capacity of 9,747 m^3 for each dam. This total capacity will be reduced based on the allocated freeboard for each dam.

Material for the construction of the dam walls will be sourced from a combination of GV borrow pits and underground mining waste. All material will be trucked in, with preconditioning, placement and rolling occurring in 300 mm increments. Once a full height of 3.0 m is reached, an excavator will trim the excess material to the designed 45º batter angle.

The inside base of the dams will be rolled to ensure no rocks, sticks or sharp items are present that could potentially impact the integrity of the liner. The dams will then be lined with a 1.5 mm HDPE liner with an underlay beneath. The liner edge will be placed in an excavated tie-in trench that will then be backfilled and compacted.

The dams will be fenced to prevent entry by livestock and native fauna and will be fitted with two fauna egress mats in the dam corners.

When operational, the 'inflow' dam will have a freeboard of 500 mm, allowing the water to flow via a spillway into the 'outflow' dam (**Figure 2-2**). The 'outflow' dam will be maintained with a freeboard of 1,000 mm. The larger freeboard in the outflow dam is required to ensure that the outflow dam has capacity to continue to receive input through the spillway from the inflow dam in the event of a failure of the main outlet pump. This will allow underground dewatering activities to continue despite a failure of the outlet pump for approximately 4 days, within which any failures would ideally be repaired, without impacts to underground activities. The resulting capacity of each dam is 7,980 m^3 and 6,272 m^3, respectively. Telemetry will be installed to provide continuous monitoring of the freeboard level within the dam and to direct the input volumes from the pumps.

2.1.1. 'Inflow' Dam

The intent of the 'inflow' dam is to provide time for sediment to settle out of the incoming water. The incoming water will be sourced from the underground mine, treated water from the oily water separator at the washdown pad and the concentrated reject from the Reverse Osmosis plant.

Excess water from the workshop will be collected in a sump and pumped to the washdown pad oily water separator for processing.

Water will travel through the spillway from the 'inflow' dam into the 'outflow' dam.

2.1.2. 'Outflow' Dam

The 'outflow' dam captures water from the 'inflow' dam that is fed through the spillway plus water from production bore GVW007P. The collected water is pumped back to the underground mine, workshop, washdown bay and to a standpipe for use in dust suppression. Any remaining excess water will be pumped back to the Processing Plant for treatment and use in processing. There is the potential for the excess water to be stored in evaporation ponds at Gossan Hill for eventual discharge into Lake Wownaminya as per Licence L8593/2011/2 Condition 21. Water quality is discussed in Section 6.4.1.

A centralised main HDPE outlet pipe (250 mm diameter) will be attached to the dam wall and fitted with isolation valving and numerous manifolds connecting various pumps. Water from this outlet will be pumped to the underground header tankers, the workshop, the standpipe and the mill (**Table 2-3**).

All pumps will be skid mounted coupled to electric motors rated and sized for operation in high ambient temperatures. Skids will be heavy duty galvanised units with a roof to provide weather protection. Matched to each pump will be appropriate isolation valves, check valves, pressure gauges and flow meters.

All pumps will have control telemetry and level indicators within the dams that can be remotely controlled from both the Gossan Valley offices as well as the Processing control room.

Table 2-3: Water Distribution Pump Summary

Pump	Flow (L/s)	Estimated Head Pressure	Pump Type	Pump kW
Underground Tank Supply	3	2 m Head pressure (tank inlet) + 38 m (friction loss) + 10m Factor = **50 m**	Vertical Multistage Pump	3
Workshop Tank Supply Pump	7	2 m Head pressure (tank inlet) + 35 m (friction loss) + 10m Factor = **47 m**	Vertical Multistage Pump	5.5
Standpipe Pump System	50	6 m Head pressure (tank inlet) + 7 m (friction loss) + 10m Factor = **13 m**	End Suction Centrifugal Pump	11
Excess Water Pump System	15	160 m Head pressure (tank inlet) + 30 m (friction loss) + 10m Factor = **200 m**	Vertical Multistage Pump	30

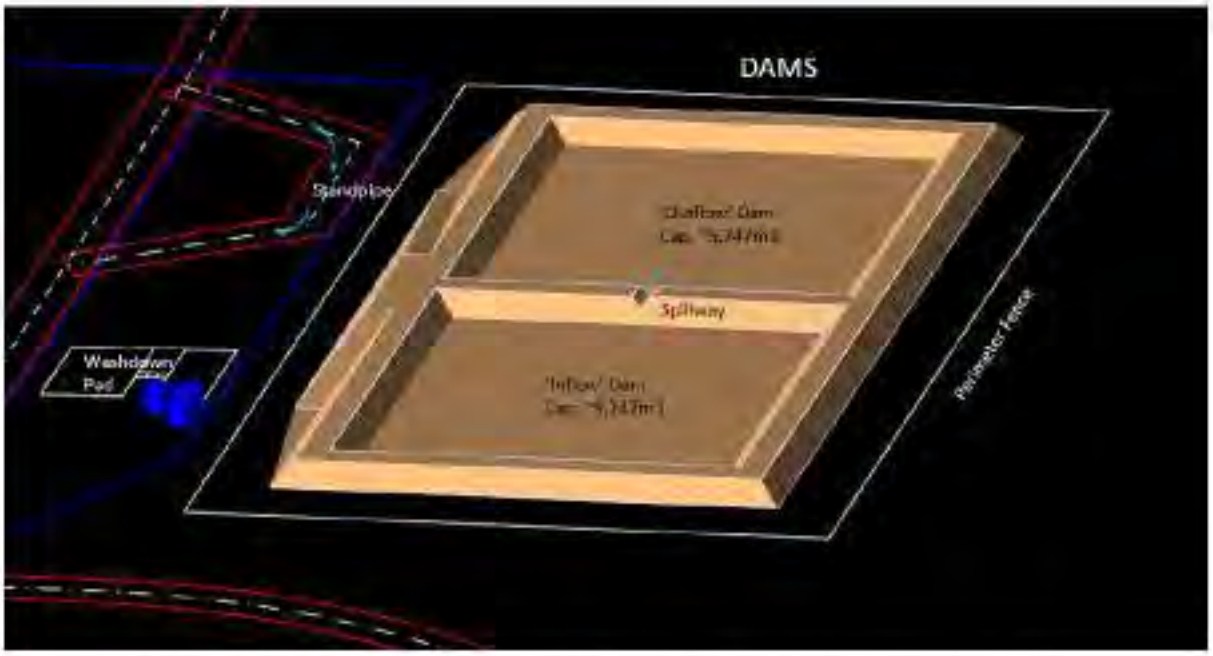

Figure 2-2: Gossan Valley 'Inflow' and 'outflow' dam (isometric view)

2.2. Dewatering Pipelines

Dewatering pipelines will be installed along existing road verges, laid within the adjacent road-side drains. The HDPE pipe will be PN12.5 class to align with the standard for underground mines. HDPE pipe lengths will be butt welded. The 63mm and 110mm diameter pipes generally are supplied in 100m coiled rolls. The 125mm diameter pipe will be transported to site in 20 metre lengths.

All pipeline runs will have either 25mm or 50mm breathers based upon a 750m spacing combined with flow meters on each pipeline.

Pipelines will be inspected once every 24 hours once commissioned. To assist in this process, appropriate leak detection will also be installed and managed. Pipeline specifications are provided in **Table 2-4**.

Table 2-4: Pipeline Specifications

Start Point	Finish Point	Pipeline Size (mm)	Pipe Type	Pipeline Length (m)
Bore GVW005P	Office RO unit	110	PN12.5 HDPE COEX	911
Bore GVW007P	'Outflow' Dam	125	PN12.5 HDPE COEX	2,006
'Outflow' Dam	Underground Water Tanks	63	PN12.5 HDPE COEX	1,866
Box-cut	'Inflow' Dam	110	PN12.5 HDPE COEX	1,501
'Outflow' Dam	Workshop Tank	110	PN12.5 HDPE COEX	200
RO Spent Tank	'Inflow' Dam	63	PN12.5 HDPE COEX	329

2.3. Bores

The two production bores to be utilised for the GVP were constructed in 2020 as part of AECOM Groundwater Assessment for GV (**Appendix A**), GVW005P and GVW007P. Both bores were developed using airlifting techniques until the water was free of sand. The production casing was set flush with the top of the surface collars and covered with a lockable steel lid.

Both bores will be equipped with headworks consisting of hose spools, check valves, butterfly valves, mechanical flow meters, pressure switches, pressure gauges and flow switches. The headworks will be housed within a galvanised, heavy-duty frame bolted to a concrete plinth.

GVW005P will be powered by solar panels and a battery. GWV007P will be initially powered by a genset, changing over to the mining power network as construction of the GVP progresses. Both bores will have telemetry that can be remotely controlled from the GV offices as well as the Processing control room. A summary of the pump set up for each bore is provided in **Table 2-5**.

Table 2-5: Production Bore Pump Summary

Bore	Flow (L/s)	Estimated Head Pressure (m)	Pump Type	Pump kW
GVW005P	3	50 m Head Pressure (draw down) + 4 m (friction loss) + 10 m Factor = **64 m**	Submersible Bore Pump	5.5
GVW007P	15	50 m Head Pressure (draw down) + 28 m (friction loss) + 10 m Factor = **88 m**	Submersible Bore Pump	18.5

2.4. Class I Landfill

The proposed landfill will consist of a single open trench that is progressively backfilled. The landfill has been situated within the approved WRD footprint, with the intention for the landfill to be progressively covered by waste material deposited as the WRD develops over the life of mine.

The landfill area will be excavated using a 120 t class excavator and 90-95 t class haul trucks. The work will occur concurrently with mining of the box-cut, with the excavation expected to take four months.

Works will commence with the clearing of vegetation and stockpiling of topsoil stripped from within the landfill footprint. Topsoil with appropriate physical and chemical characteristics for use in rehabilitation at closure will be stockpiled in the vicinity of the landfill area.

The caprock will be ripped by a dozer, with the potential to be blasted where it is too thick for the mobile equipment to penetrate. Load and haul will be carried out by an excavator and trucks in 2.5 m flitches. No ore is expected within the landfill excavation, with all material excavated to be hauled to the GV waste rock dump. Some material may also be utilised in the construction of other surface infrastructure.

The total material movement is expected to be 26,496 bcm, based on the design attributes detailed in **Table 2-6**.

A 3 m high, 7 m wide perimeter safety and wind bund will be progressively constructed around the landfill trench. There will be a managed tip head no wider than 20 m, progressively covered by NAF fresh rock. The NAF rock will establish the new tip head in readiness for placement of inert waste type 1 material (**Appendix G**).

The proposed layout for the landfill is depicted in **Figure 2-3** and isometric and sectional views of the landfill are included in **Appendix H.**

Table 2-6: Landfill Design Attributes

Feature	Unit	Measurement
Surface	mRL	1356
Trench base	mRL	1352
Length	m	115
Width	m	71
Depth	m	4
Volume (including ramp)	m^3	26,496
Ramp Gradient	Ratio	1:11
Overall Wall Angle for Depth	degrees	45

A composite set of groundwater levels derived from monitoring conducted by AECOM in 2020 indicates the vertical depth to water ranges from 7.38 mbgl to 43.79 mbgl (AECOM, 2020). Depth to groundwater of bores proximal to the landfill site ranged from 26 m to 44 m (AECOM, 2020).

For a more detailed outline of the management of the proposed Landfill, please see the Non-Mineral Waste Management Plan, attached as **Appendix F**.

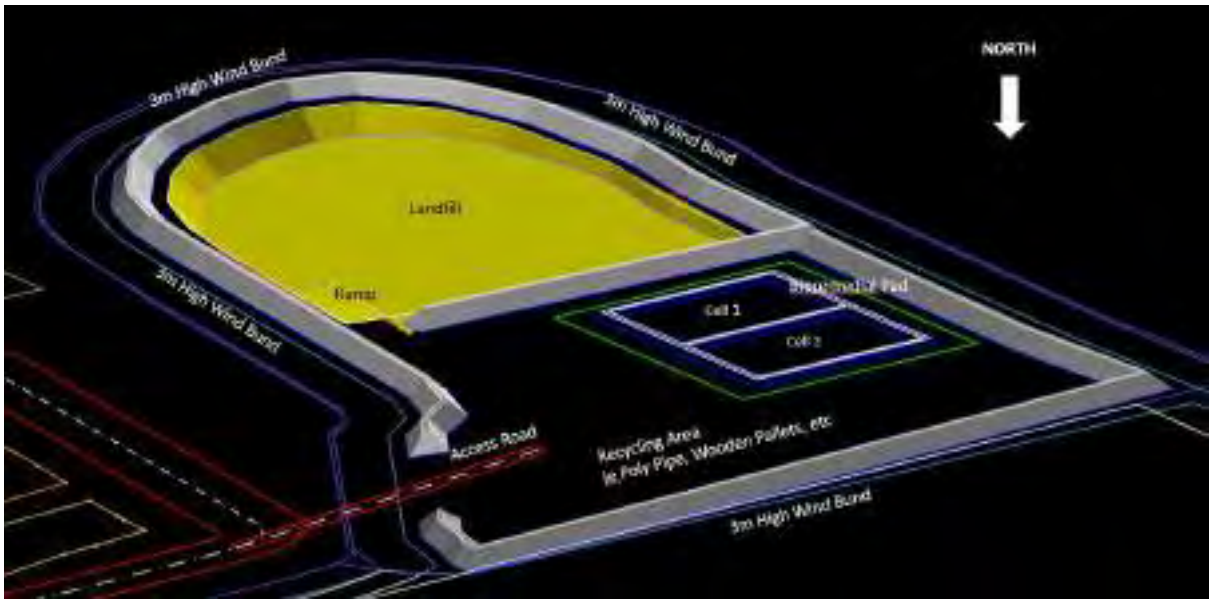

Figure 2-3: Proposed layout for Landfill site

4. Statutory Considerations

4.1. EP Act Part V

Works Approvals and Licences have previously been applied for and granted for the Golden Grove Project. The Premises currently holds one Licence under Part V of the EP Act; L8593/2011/2.

Licence L8593/2011/2 for Golden Grove currently authorises:

- Category 5: Processing or beneficiation of metallic or non-metallic ore authorised by DWER in L8593/2011/2 for throughput of 2,100,000 tonnes per annual period;
- Category 6: Mine dewatering authorised by DWER for 3,500,000 tonnes per annual period;
- Category 54: Sewage facility authorised by DWER for 300 cubic metres (m^3) per day;
- Category 61: Liquid waste facility authorised for 5,000 tonnes per annual period; and
- Category 89: Putrescible landfill site authorised for not more than 5,000 tonnes per annual period.

Clearing permit CPS 9046/1 is approved and has been active from 19th December 2020 as per *Environmental Protection Act 1986 (Part V) Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

4.2. Mining Act 1978

A Mining Proposal for the Gossan Valley Project was submitted in March 2024 with an associated Mine Closure Plan. GGO plan to consolidate all Mining Act Approvals by 2025.

4.3. Rights in Water and Irrigation (RIWI) Act 1914

GGO holds *Rights in Water and Irrigation Act 1914* (RIWI Act) licence Ground Water Licence (GWL) 103574(8) that provides for abstraction limit of 3.51 giga litres (GL) of groundwater per annum. A second abstraction licence has been submitted and approved to allow for abstraction of 500,000 kL from the Gossan Valley bore (GVW007P), located to the southeast of the existing operations – GWL209427(1).

An amendment to GWL103574(8) will be submitted to authorise the abstraction from Gossan Valley bore GVW005P.

5. Stakeholder Engagement

Stakeholders are individuals, government agencies, community groups or others who have the potential to be affected by or have an interest in the Golden Grove Project. Golden Grove recognises that stakeholder consultation and engagement is a critical component of their operations. Stakeholder consultation and engagement is required prior to operation, during operating and during the closure process.

The key stakeholders consulted during the preparation of this licence amendment and other related approvals/documentation were:

- The Department of Mining, Industry Regulation and Safety (DMIRS);
- Department of Biodiversity, Conservation and Attractions (DBCA);
- Department of Planning, Lands and Heritage (DPLH);
- Department of Fire and Emergency Services;
- Department of Planning, Lands and Heritage (DPLH);
- The DWER;
- Shire of Yalgoo;
- Midwest ports;
- Geraldton Chamber of Commerce & Industry;
- Yamatji Nation;
- Badimia People;
- Bajda Station;
- Bunnawarra Station;
- Muralgarra Station;
- Thundelarra Station; and
- Warridar Minjar Gold Pty Ltd Station.

A Stakeholder Engagement Register relevant to the proposed licence amendment is provided in Error! R eference source not found..

6. Existing Environment

6.1 Climate

Golden Grove mine is situated within the Murchison region and Yalgoo bioregion, has a variable climate with characteristics of semi-arid and Mediterranean climates, and is prone to long periods of drought. Most rainfall occurs during the winter months, although more occasional major rainfall events, largely associated with tropical cyclone activity off the northwest shelf, occur in the summer months and can result in localised flooding.

The nearest BoM weather station to the Project is Morawa Airport (Station 8296). The annual average rainfall recorded at the Morawa Airport weather station is 286.6 mm.

Long-term monthly rainfall averages and temperature are shown in Figure 6-1 based on the Morawa Airport data between 1997-2022 (BoM, 2023).

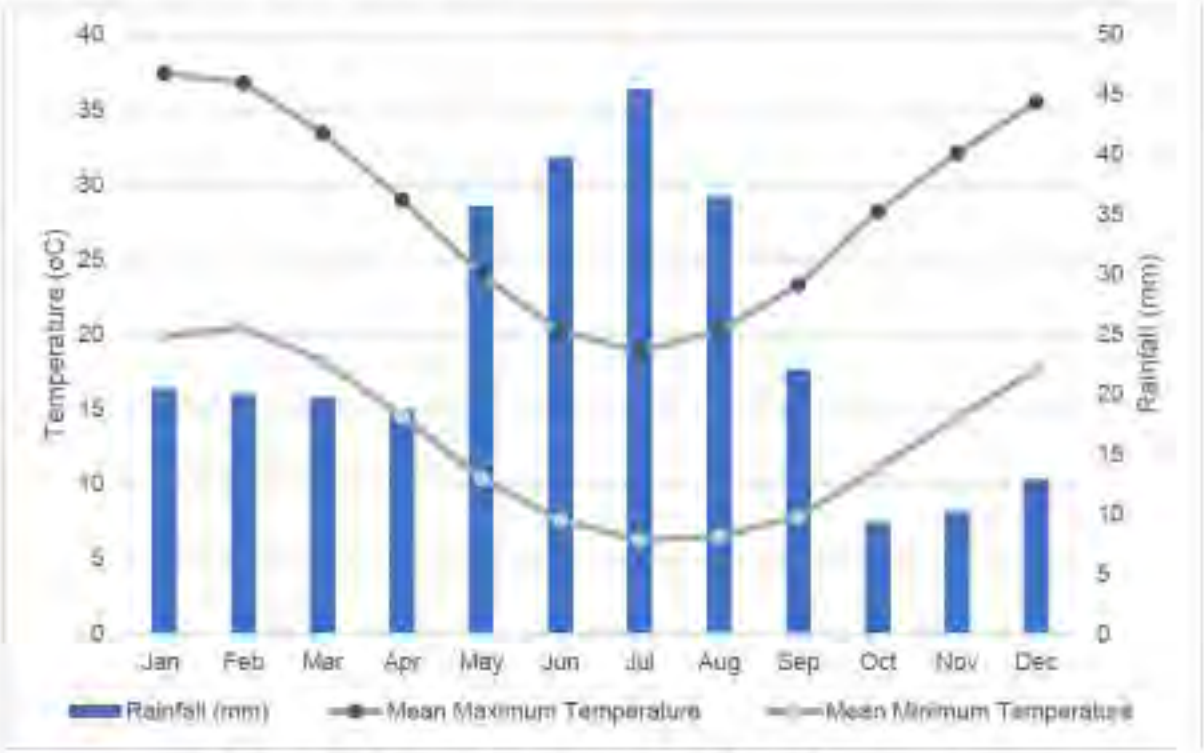

Figure 6-1: Long Term Monthly Rainfall and Evaporation

While the long-term average monthly rainfall totals are similar, in practice, the site often receives more rainfall in the winter months due to frontal systems from the southwest and occasionally high totals in the summer due to rain-bearing depressions (ex-tropical cyclones) from the north. Rainfall of more than 30 to 50 mm is likely to contribute to groundwater recharge if it occurs over a few successive days. Below that the rainfall contributes to soil moisture only.

On average, the evaporation rate is 2,583mm with monthly totals in the order of ten times the corresponding rainfall rates. This is typical for inland areas of WA and is responsible for the absence of permanent surface water in the region (GHD, 2020).

Prevailing winds at the Project are north-easterly in the mornings (0900hrs) with an average speed of 17.9km/h (BoM, 2023). In the afternoons, direction varies by season, ranging from south-easterlies in the summer to north-westerlies in the winter and south-westerlies in the spring. The average afternoon (1500hrs) wind speed is 19.0km/h (BoM, 2023). Wind roses for Morawa Airport (1997-2022) are presented below in Figure 6-2.

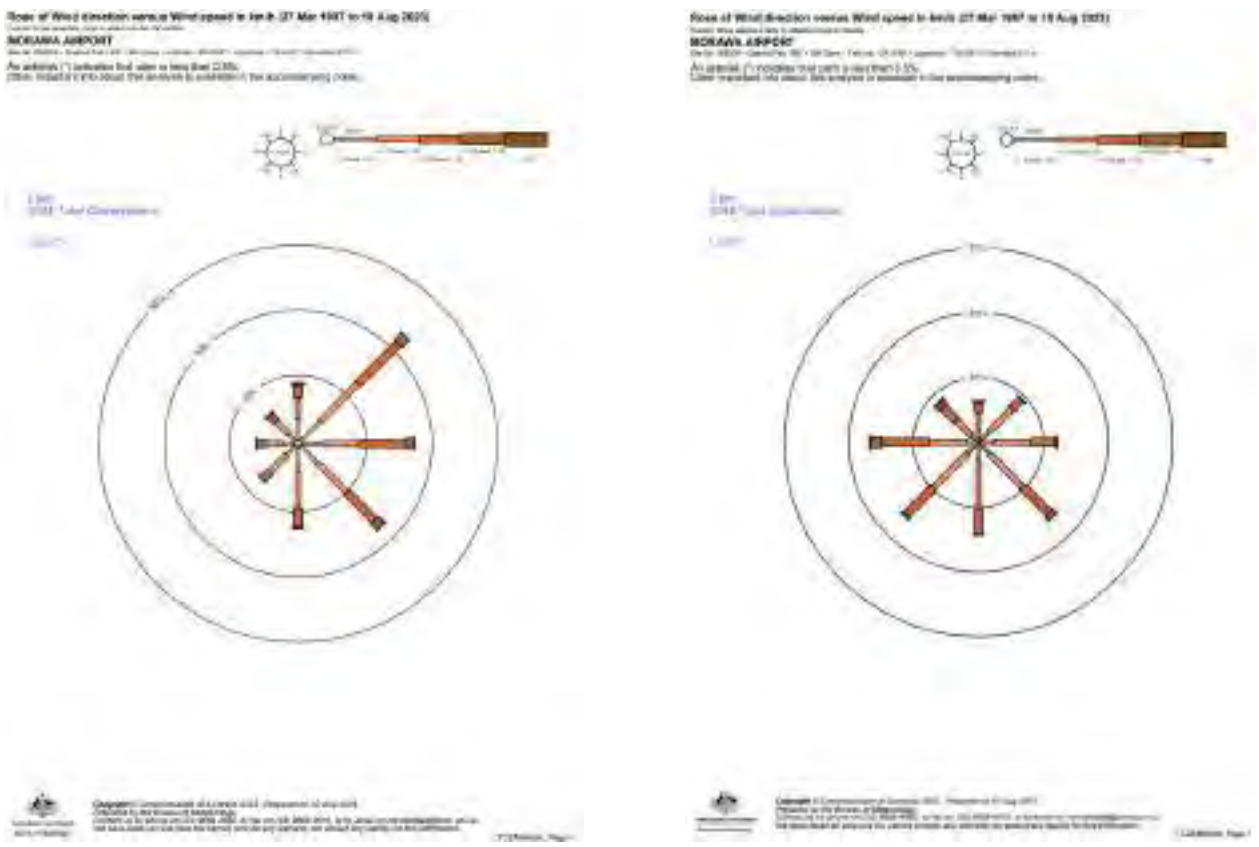

Figure 6-2: Wind Roses for Morawa Airport (Station ID 8296) from 1997-2022

6.2 Topography and Soils

The area surrounding the Golden Grove mine site is of low to moderate relief with long ranges separated by extensive plains. Elevation is generally around 350m above sea level with the highest point in the region being Minjar Hill to the west, approximately 380m above sea level. The main feature of the immediate operational tenements is Gossan Hill which is an isolated hill on the plain between a range to the west and breakaways in the east.

Golden Grove is located on a topographic divide with the majority of the mine infrastructure located in a wide shallow valley which drains to the southwest towards Minjar Hills. The valley is surrounded by a low ridge of volcanoclastic rocks and meta-sedimentary rock types. The geological formations in the Golden Grove site area are often intruded by dykes and sills of dolerite and dacite (URS 2009)

The Golden Grove site is located within the Yalgoo biogeographic subregion, which is characterised by open woodlands (principally *Callitris*, *Eucalyptus salubris*, Mulga and Bowgada) and scrubs on earth or sandy earth plains (CALM 2002). The subregion represents the boundary between the Murchison and Southwestern bioregions with features of both bioregions represented in the Yalgoo subregion.

Maia Environmental Consultancy (Maia) (**Appendix B**) identified three land systems within the study area (**Figure 6-3**) that are located at the proposed GVP location (Maia, 2020). These are in Table 6-1 summarised below:

Table 6-1: Land Systems identified at the Gossan Valley Project survey area (Maia,2020)

Land System	Description	Area (ha)
Kalli System	Elevated gently undulating red sandplains edged by stripped surfaces on laterite and granite, supporting acacia tall shrublands with wanderrie grass understoreys.	12.91
Tealtoo System	Level to gently undulating loamy plains with fine ironstone gravel mantles supporting dense acacia shrublands.	70.68
Watson System	Hills, rises and gravelly plains on sedimentary rocks supporting bowgada shrublands with non-halophytic undershrubs.	320.09
Total		**403.68**

6.3 Geology

The Golden Grove area is located in the Murchison province of the Archean Yilgarn Craton of WA. The Yilgarn Craton consists of linear to arcuate greenstone belts within an extensive terrane of intrusive granitoid and granitic gneiss. The Warriedar Fold Belt, one of the larger greenstone belts in the Murchison province, contains the volcanic hosted massive sulfide (VHMS) deposits of the Golden Grove district (e.g., Scuddles, Gossan Hill, Felix, Gossan Valley, Grassi and Flying Hi (Tetrakis, 2020).

The Warriedar Fold Belt is characterised by heterogenous deformation with narrow zones of high strain separating less deformed areas. The Warriedar Fold Belt consists of tholeiitic basalt, banded iron formation and felsic volcanic and sedimentary rocks, which range in age from 2.6 billion years to 3.0 billion years. The Warriedar Fold Belt is subdivided into five tectonostratigraphic domains (Gnows Nest, Golden Grove, Chulaar, Windaning and Fields Find Domains). Five major faults (Mongers, Mougooderra, Pincer, Windaning and Rothsay Faults) represent the structural discontinuities that occur within the Warriedar Fold Belt (Tetrakis, 2020).

The Golden Grove Domain hosts the VHMS deposits and lies along the north-eastern flank of the Warriedar Fold Belt. The majority of the Golden Grove Domain is located to the west of a north trending, sub-vertically plunging anticline resulting in the stratigraphy dipping steeply to the west. The Golden Grove Domain contains a layered succession of felsic to mafic volcanic and volcaniclastic rocks deposited within a deep subaqueous environment. Most of the rocks in the Golden Grove Domain have been metamorphosed to greenschist facies, after the deposition of the sulfides (Tetrakis, 2020).

The stratigraphy of Golden Grove Domain is subdivided into three recognised groups: (1) Gossan Hill Group; (2) Thundelarra Group; and (3) the Minjar Group. The VHMS deposits in the Golden Grove district occur in the Gossan Hill Group, which has an average thickness of 3 km and a north-south strike extent of 28 km. The Gossan Hill Group is dominated by felsic to intermediate volcaniclastic rocks, volcanogenic sediments and exhalates. The Gossan Hill Group (from base to top) is divided into the Shadow Well, Gossan Valley, Golden Grove, Scuddles, and Cattle Well Formations (Tetrakis, 2020).

The lowest stratigraphic formation of the Gossan Hill Group is the Shadow Well Formation, which consists of poorly sorted quartz-feldspathic sandstone. It has an estimated thickness ranging from 150 m to 1100 m. The formation has intrusive contacts against recrystallised monzogranite (northeast) and conformable contacts with the overlying Gossan Valley Formation (southwest).

The Gossan Valley Formation occurs in the eastern part of the Golden Grove Domain and varies in thickness from 170 m to 920 m. This formation consists of polymictic sandstone and breccia, with minor felsic and mafia volcanics. The Gossan Valley Formation is conformably overlain and underlain by the Golden Grove and Shadow Well Formations, respectively. In the southeast, the Gossan Valley Formation is truncated by post-folding granite intrusions. This formation is divided into four members (Members 1-4) that consist of mixed provenance litharenite, coherent basalt, rhyodacite, dacite and quartz arnite facies (Tetrakis, 2020).

The Golden Grove Formation is a layered sequence of felsic volcaniclastic rocks ranging from 75 m to 800 m in thickness and is overlain by felsic lavas and intrusions of the Scuddles Formation (west). The Golden Grove Formation consists of rhyolitic to andesitic tuffaceous sediments, minor sedimentary, felsic volcanics and both massive sulfide and magnetite. The formation of magnetite and sulfide is suggested to have formed during the deposition of the upper Golden Grove Formation.

The Scuddles Formation consists of dacite with minor rhyodacite volcanics and sedimentary rocks. The formation varies in thickness from 730 m to 990 m and is located in the central part of the Golden Grove Domain. The Scuddles Formation is conformably overlain by the Cattle Well Formation and is divided into four stratigraphic members.

The Cattle Well Formation is bounded to the northeast by the Scuddles Formation and to the southwest by the overlying Thundelarra Group. The formation has a thickness ranging from 900 m to 1450 m and has a northwest trending outcrop within the Golden Grove Domain. The main lithologies within the Cattle Well Formation are polymictic sandstone and breccia, with minor coherent basalt.

At Golden Grove, strata bound sulfide-magnetite mineralisation occurs in a 1 km thick felsic volcanoclastic sequence, consisting of fine and coarse-grained pyroclastic rocks, volcanogenic sediments, and minor flow rocks. Outcropping occurs mainly at the site of mineralisation rather than in the surrounding countryside. The Gossan Valley deposit is located approximately 6.5 km south of Gossan Hill. Sphalerite and chalcopyrite are the main sulfides at Gossan Valley and the Zn-rich ore zone is stratigraphically above the copper (Tetrakis, 2020).

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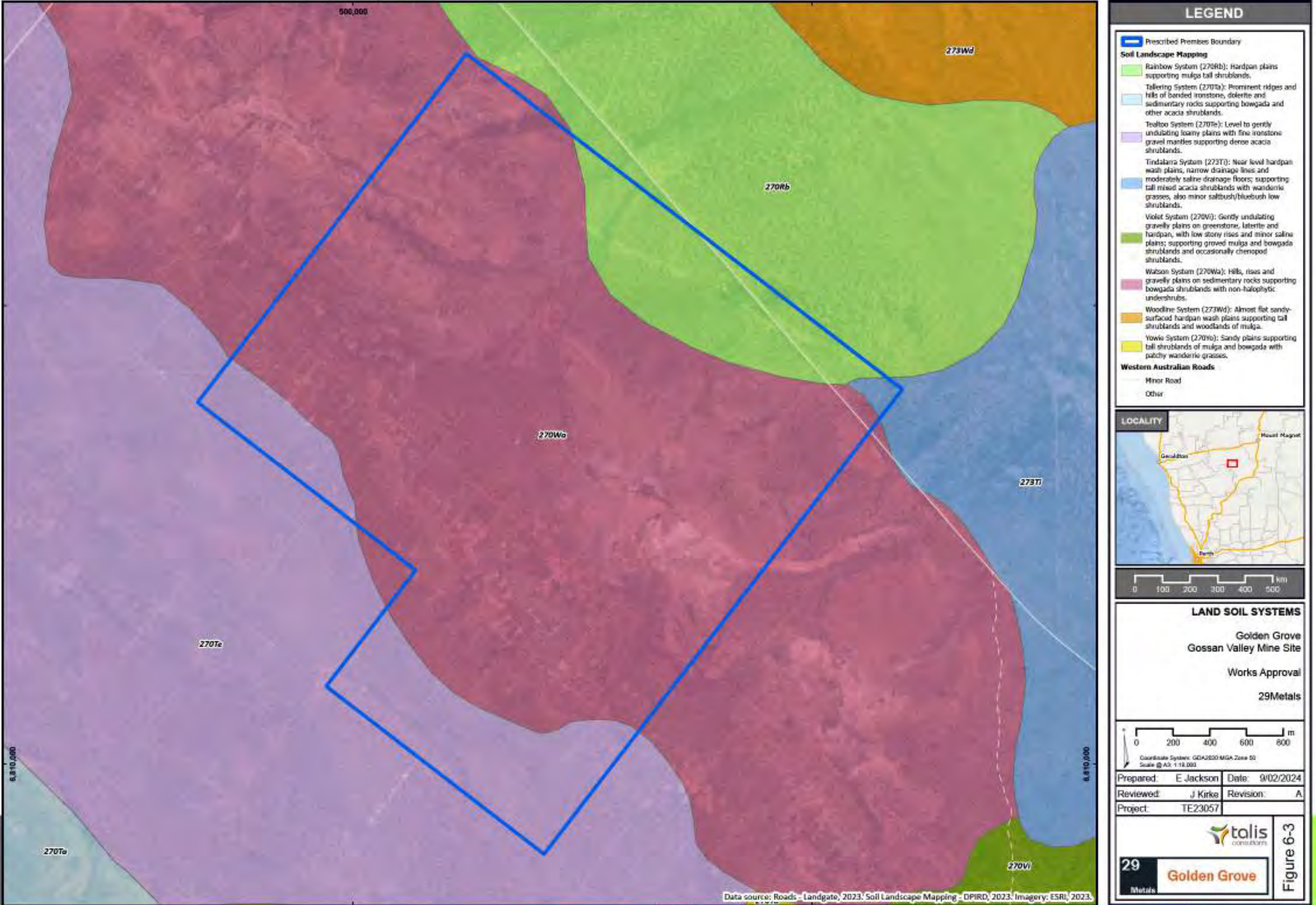

500,000
6,810,000
273Wd
270Rb
270Wa
273Ti
270Te
270Ta
270Vi
Data source: Roads - Landgate, 2023. Soil Landscape Mapping - DPIRD, 2023. Imagery: ESRI, 2023.
LEGEND
Prescribed Premises Boundary
Soil Landscape Mapping
Rainbow System (270Rb): Hardpan plains supporting mulga tall shrublands.
Tallering System (270Ta): Prominent ridges and hills of banded ironstone, dolerite and sedimentary rocks supporting bowgada and other acacia shrublands.
Tealtoo System (270Te): Level to gently undulating loamy plains with fine ironstone gravel mantles supporting dense acacia shrublands.
Tindalarra System (273Ti): Near level hardpan wash plains, narrow drainage lines and moderately saline drainage floors; supporting tall mixed acacia shrublands with wanderrie grasses, also minor saltbush/bluebush low shrublands.
Violet System (270Vi): Gently undulating gravelly plains on greenstone, laterite and hardpan, with low stony rises and minor saline plains; supporting groved mulga and bowgada shrublands and occasionally chenopod shrublands.
Watson System (270Wa): Hills, rises and gravelly plains on sedimentary rocks supporting bowgada shrublands with non-halophytic undershrubs.
Woodline System (273Wd): Almost flat sandy-surfaced hardpan wash plains supporting tall shrublands and woodlands of mulga.
Yowie System (270Yo): Sandy plains supporting tall shrublands of mulga and bowgada with patchy wanderrie grasses.
Western Australian Roads
Minor Road
Other
LOCALITY
Mount Magnet
Geraldton
Perth
0 100 200 300 400 500 km

LAND SOIL SYSTEMS

Golden Grove
Gossan Valley Mine Site

Works Approval

29Metals

0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:18,000

Prepared:	E Jackson	Date:	9/02/2024
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

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29 Metals Golden Grove

Figure 6-3

6.4. Hydrogeology

A desktop study was undertaken in 2012 by AECOM Australia (then URS Australia) to investigate the likely groundwater conditions and risk for the GVP. This study identified the presence of groundwater in an aquifer comprising weathered and fractured bedrock and possibly superficial sediments in a shallow palaeovalley to the south. An investigation program was developed to support a detailed assessment by AECOM in 2020 (**Appendix A**).

Groundwater at the GVP occurs in weathered and fractured bedrock. The main aquifer across the site is the partly weathered saprock interval that resides between the fresh bedrock and clayey saprolite. Highly permeable zones associated with deep regional fracture systems known from Gossan Hill have not been detected at the GVP and generally the fresh bed rock at GV does not appear to be permeable (AECOM, 2020a).

The hydrostratigraphy of the GVP area typically includes (from top to bottom) (AECOM, 2020a):

- Unsaturated alluvium and pisolite along the mid-slopes of the ridgelines and valley floors towards the upper ends of the catchments. These deposits have been deposited in alluvial fans and may contain porous lateritic gravel and sand interbedded within silty sand. Local ferricrete development in the profile can lead to preferential pathways that can transmit rainfall recharge to low lying areas;
- Caprock comprising calcreted or ferruginous saprolite is regionally extensive and typically massive, poorly to non-fractured, and of low hydraulic conductivity unless disturbed by excavation or blasting associated with site earthworks. This unit is unsaturated but is influential to recharge rates because of its low permeability;
- Extremely weathered saprolitic clay that is normally of low to very low hydraulic conductivity. This unit is extensive, but not continuous across Golden Grove and is often absent along the ridgelines where it has been eroded. It often contains relict structures that may form preferential pathways to seepage, but generally is an aquitard;
- An extensive saprock interval that is of variable thickness comprising partially weathered bedrock containing discontinuities because of dissolution of minerals, or stress relief due to exposure or unloading by weathering. This interval is continuous across the Golden Grove area. In hydraulic terms, it varies between being an aquitard to aquifer of low to moderate hydraulic conductivity. Locally, this is highly transmissive where partially weathered dolerite coincides with fault or shear zones; and
- The fresh bedrock is generally massive and non-fractured and is regarded as a regional aquitard. Exceptions to this do occur such as the deep-seated fracture system intersected by the Gossan Hill mine and deep fractured contacts as intersected by Scuddles water bores GGW67P and GGW69P. These deep-seated fractures are semi-continuous but are connected to overlying saprock and saprolitic deposits.

Groundwater levels at a regional scale vary in-sync with the topography (although more subdued) because it occurs in the fractured and weathered bedrock and flows by gravity from elevated areas to low lying areas. Groundwater from the Scuddles and Gossan Hill areas flows towards the break in Gnowns Nest Range alongside Phillips Hill and towards Minjar well, prior to dewatering in the Golden Grove area. Outside this local catchment, groundwater flows north of Scuddles to Cattle Creek, and west and north-west of Gnowns Nest Range to lower elevated areas on Badja Station. Baseline groundwater levels in the TSF4 location ranged from 325m AHD to 337.5m (AHD) on Cattle Creek, to 336 near TSF2 (AECOM, 2020a).

Topographically driven flow was also present as inferred by gradients from these baseline observations (AECOM, 2020a). This relationship between topography and baseline groundwater levels has been observed in the broader Golden Grove region. Generally, groundwater levels are lower to the north and northwest along Cattle Creek, however higher locally along the ridge lines.

Dewatering will be required in the lower most 9 m of the box-cut, with a predicted dewatering rate of 50kL/day (AECOM, 2020a). It is predicted that the salinity of groundwater abstracted for dewatering from GV is likely to increase with time as the fresher water is drained from the more permeable sections of the aquifer. This trend is apparent in the abstraction salinity records from Scuddles and Gossan Hill. Salinity at the GVP may increase with time from about 2,000 mg/L total dissolved solids (TDS) to between 4,000 and 5,000 mg/L TDS (AECOM, 2020a).

6.4.1. Groundwater Quality

Analysis of groundwater quality data by AECOM (2020) indicates groundwater at Gossan Valley is:

- Near neutral to weakly alkaline: pH 7.10 to 7.84;
- Fresh to brackish: 706 to 3,470 mg/L TDS;
- Slightly hard to very hard: 113 to 609 mg/L (as $CaCO_3$);
- Of the sodium chloride type: dominated by sodium and chloride ions more so than most bores in the Gossan Hill and Scuddles areas;
- Contains detectable dissolved zinc at all sites and several other trace metals at some sites;
- Contains low nutrient concentrations;
- Does not contain detectable hydrocarbons at the four sites tested for this parameter;
- Contains major and trace ions below the respective groundwater and surface water limits specified in Licence L8593/2011/2.

GV groundwater quality was also compared to groundwater quality data from Gossan Hill and Scuddles.

The average pH and sulphate to chloride ratio at GV is similar to values from Gossan Hill in the early 2000s. The salinity at GV is lower than groundwater abstracted from the Gossan Hill and Scuddles mines in their early stages of dewatering (AECOM, 2020).

Hydrochemistry of groundwater at GV was compared to mean concentrations between 2016 and 2018 in groundwater from GGW67P and GGW69P at Scuddles and GHDEC44P at Gossan Hill, and excess mine water that has been discharged to Lake Wownaminya (Appendix F in AECOM, 2020). The results indicate:

- Solute concentrations in groundwater from GV are similar to the groundwater at Gossan Hill and Scuddles prior to dewatering at the site;
- Groundwater from GV is hydrochemically similar to groundwater abstracted from the Gossan Hill and Scuddles areas;
- Metal(loid) and nutrient concentrations are low from all sites, including GV; and
- The concentrations of all groundwater parameters at GV are below ambient water quality limits for groundwater at Gossan Hill and Scuddles and emission limits for surface water listed in Licence L8593/2011/2.

6.5. Hydrology

The Project is located on the semi-arid Murchison Region of WA, close to the Wheatbelt Region, with most of the GVP being located on the former Warriedar Pastoral Lease. Fluctuating rainfall patterns contribute to highly variable surface water flows, which only occur following intense rainfall events (AECOM, 2020b). Monthly evaporation rates far exceed the corresponding rainfall rates, as such there are no permanent surface water bodies in the region (**Figure 6-4**).

The GVP area straddles a central catchment divide that trends northwest to southeast (AECOM, 2020b). The Gossan Valley Catchment drains southeast then east towards Thundelarra Station. To the east of the GVP, minor sub-catchments drain from the central catchment divide eastwards across the Yalgoo Ninghan Road before also trending south towards Thundelarra Station (AECOM, 2020b). The Project site represents a very small area of the total catchment and is in the far upper reaches of the three expansive drainage areas.

During the 2020 study by AECOM, it was noted that exploration tracks crossed multiple surface water structures, indicative of potential impacts to catchment flows. There was evidence of erosion at surface water sample locations, suggesting that surface water flows do have the capacity to cause erosion and transfer sediments downstream following significant rainfall events (AECOM, 2020b).

There are no known surface water abstractions or uses near the GVP that may be affected by the proposed works. All the pastoral stations in the GVP have been destocked and therefore have no dependency on surface water (AECOM, 2020b).

The local surface water structures for the GVP are mapped in **Figure 6-4**.

6.5.1. Surface water quality

Results of surface water quality studies indicate that surface water at the GVP has naturally high levels of cadmium, chromium, copper and zinc (AECOM, 2020b). These higher, naturally occurring concentrations need to be noted in surface water quality guidelines used to manage the operation.

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Data source: Roads – Landgate, 2023. Watercourse – Geoscience Australia, 2023. Imagery: ESRI, 2023.

LEGEND

- Prescribed Premises Boundary
- Watercourse

Western Australian Roads

- Minor Road
- Other

LOCALITY

0 100 200 300 400 500 km

HYDROLOGY

Golden Grove
Gossan Valley Mine Site

Works Approval

29Metals

0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:18,000

Prepared:	E Jackson	Date:	9/02/2024
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

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29 Metals Golden Grove

Figure 6-4

6.6. Flora and Vegetation

6.6.1. Survey Effort

The Maia 2020 survey included a desktop study that aimed to identify threatened flora, priority flora, weed species, threatened ecological communities, priority ecological communities, environmentally sensitive areas, groundwater dependent ecosystems (**Appendix B**).

Following a desktop survey, a two-phase on-site survey was conducted. The first phase was in September 2019 and the second in April 2020.

The 2019 threatened flora survey involved in-field surveys of the areas where *Stylidium scintillans* had been previously recorded to count the number of plants present in 2019 (**Appendix B**).

Survey Results – Flora

A brief summary of the survey results for flora is provided below (Maia, 2020a):

- Two hundred and forty-four taxa from 120 genera and 51 families were recorded in the survey area (70% perennial and 30% annual) **(Figure 6-5).** The survey area is not recognised for its high species richness, and the species accumulation curve indicated that 90% of the species estimated to be in the survey area were recorded;
- No threatened flora species protected by the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were recorded in the survey area. One threatened species protected by the WA *Biodiversity Conservation Act 2016* (BC Act) was located, identified as *Stylidium scintillans* (vulnerable);
- Four Priority 3 (P3) flora species were recorded during the surveys: *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096), *Drummondita fulva, Grevillea globose* and *Micromyrtus trudgenii*;
- Two regional endemic species (*Stylidium scintillans* and *Drummondita fulva*), three range extension species (*Austrostipa macalpinei, Schismus arabicus* and *Thryptomene globifera*), and one potential new species (*Acacia* sp. nov.) were located in the survey area;
- Sandalwood (*Santalum spicatum*) (a controlled species under the BC Act) was located in the survey area;
- No nationally listed or WA listed weed species were located in the survey area, while 11 general environmental weed species were. Two of the 11 have both a high ecological impact and rapid invasiveness rating (*Aira caryophyllea* and *Mesembryanthemum nodiflorum*); and
- In 2019 fewer *Stylidium scintillans* were located than in 2011 (1,384 plants compared with 157,147 plants). The difference can be explained by the rainfall in the preceding three months (98.7 mm less in 2019 than 2011) and the slightly later survey timing in 2019. A first pass *S. scintillans* regional habitat assessment indicated that 42.57% of the regional area was predicted to be suitable habitat.

Survey Results – Vegetation

A brief summary of the survey results for vegetation is provided below (Maia, 2020a):

- Thirteen vegetation types were mapped in the different habitats of the survey area (11 Acacia tall shrublands of varying density, one mixed chenopod shrubland and one mixed low shrubland) (**Figure 6-6**);
- Five of the vegetation types were mapped between 10.7% and 12% of the survey area (all Acacia tall shrublands), three between 5.8% and 8.4% (all Acacia tall shrublands) and the remainder

between 0.8% and 4.5% (one Acacia tall shrubland, the mixed chenopod shrubland and the mixed low shrubland);

- Survey area vegetation condition was mapped as 38% Excellent, 51% Very Good, 4% Good and 7% Degraded to Completely Degraded. Vegetation in the centre of the survey area and in the hillier areas is in the best condition (Excellent). Vegetation is poorest along the saline flats and drainage channels dominated by halophytic shrubs and on one of the hilly areas preferentially used by goats;
- No groundwater dependent vegetation (GDV) occurs in the survey area. No large drainage lines occur with tall trees along them, and therefore it is unlikely that any of the vegetation types are groundwater dependent ecosystems. Water levels in the area mapped as Mixed Chenopod Shrubland where *Tecticornia* species were located are 15.1 m below ground level, making it unlikely that this vegetation is groundwater dependent.

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6,814,000 6,813,000 6,812,000 6,811,000 6,810,000

Data source: Roads - Landgate, 2023. Imagery: ESRI, 2023.

LEGEND

Prescribed Premises Boundary

Threatened and Priority Flora (Maia Environmental Consultancy)

Priority Status not Listed

- Acacia sp. Nov
- Brachychiton gregorii
- Cucumis myriocarpus subsp. myriocarpus
- Cuscuta epithymum
- Hypochaeris glabra
- Mesembryanthemum nodiflorum
- Pentameris airoides subsp. airoides
- Rostraria pumila
- Rumex hypogaeus
- Santalum spicatum
- Schismus arabicus
- Sonchus oleraceus
- Spergula pentandra

Priority 3

- Drummondita fulva
- Grevillea globosa
- Micromyrtus trudgenii

Threatened

- Stylidium scintillans

Western Australian Roads

- Minor Road
- Other

LOCALITY

0 100 200 300 400 500 km

FLORA

Golden Grove
Gossan Valley Mine Site

Works Approval

29Metals

0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:18,000

Prepared:	E Jackson	Date:	12/02/2024
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

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29 Metals Golden Grove

Figure 6-5

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6,814,000 6,813,000 6,812,000 6,811,000 6,810,000

LEGEND

Prescribed Premises Boundary

Vegetation Types

- Disturbed
- Low Shrubland to Low Open Shrubland
- Low mixed Chenopod Shrubland
- Tall Open Shrubland of Acacia effusifolia
- Tall Open Shrubland of mixed Acacia species
- Tall Open Shrubland to Tall Sparse Shrubland of Acacia aulacophylla
- Tall Shrubland of Acacia effusifolia and A. sibina
- Tall Shrubland to Tall Open Shrubland of mixed Acacia species

Western Australian Roads

- Minor Road
- Other

LOCALITY

0 100 200 300 400 500 km

VEGETATION TYPE

Golden Grove
Gossan Valley Mine Site

Works Approval

29Metals

0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:18,000

Prepared:	E Jackson	Date:	12/02/2024
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

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29 Metals Golden Grove

Figure 6-6

Data source: Roads - Landgate, 2023. Imagery: ESRI, 2023.

6.6.2 Conservation Significant Flora

Five conservation significant (CS) flora species have been recorded in the survey area.

These species are described in the **Table 6-2** below:

Table 6-2: Conservation significant flora species located in the Survey Area

Species	Conservation Status	Description
Stylidium scintillans	Threatened, vulnerable (BC Act)	Cormaceous ephemeral herb 3-8 cm height. Grows in seasonally wet habitats or moist pockets of soil at the fringes of granite outcrops. The flower is white with red-pink throat markings.
Calotis sp. Perrinvale Station (R.J. Cranfield 7096)	Priority 3	Small annual daisy in the Asteraceae family. Grows to 0.3 m high with leaves with widely spaced teeth on their margins and scattered hairs on their surface. Red flower heads are produced in spring, followed by spike fruit. Eleven plants were recorded from two locations on hard plains in the survey area.
Drummondita fulva	Priority 3	Erect branching shrub growing from 0.5 to 1.5 m tall. The leaves are fleshy and distinctively club shaped with glands along the lower surface. The flowers are terminal and range from green to red at maturity. The species is endemic to the Tallering subregion of the Yalgoo bioregion. 222 plants were recorded on hills and outcrops.
Grevillea globose	Priority 3	Spreading shrub growing between 1 and 3 m high. The leaves alternate and range from 60 to 200 mm long with hairs along the upper surface and the leaf margins completely enclosing the lower surface. The flower heads can be axillary or terminal and range from green, white to brown. 127 plants were recorded on hard plains, sandplains and undulating plans/
Micromyrtus trudgenii	Priority 3	Erect, open, straggly and weeping shrub growing to 2 m in height. The leaves are 4 to 9 mm long and are densely arranged on the smaller branches. The species produces yellow flowers. 650 plants were identified on hills, low rises, outcrops and ranges within the survey area.

Stylidium scintillans is known to occur within the Golden Grove project area, as such a targeted flora survey was commissioned by the Proponent to assess the number of plants present in 2019, compared to 2011. Recorded numbers of the species in 2019 were significantly lower than in 2011, 1,384 and 157,147, respectively (Maia, 2020b). *S. scintillans* was located at 22 of the 35 populations identified in 2011. It is most likely that the reduction in identified plants is due to the reduced rainfall for the 2019 autumn/winter period compared with autumn/winter in 2011 (Maia, 2020b).

Three hundred and ten *Stylidium scintillans* lie within the proposed Prescribed Premises boundary, however, only two *Stylidium scintillans* individuals lie within the proposed Mine Development Envelope (MDE) (**Figure 6-7**).

A regional habitat assessment was performed for *S. scintillans* and it was determined that it is likely the species will occur in more areas than it has been found to date and in more areas outside of the MDE on the hills of the neighbouring ranges (Maia, 2020b).

Taxa of Interest – WA Sandalwood

WA sandalwood (*Santalum spicatum*) is a slow-growing, long-lived, small woody tree or shrub that occurs naturally throughout the southern part of WA and into South Australia (Maia, 2020a). It is valuable and highly sought after for the oils contained in the heartwood. Sandalwood is a controlled species under the BC Act and it cannot be taken from private land or from Crown land to be processed without a licence unless an exemption applies. Thirty-eight *S. spicatum* were recorded within the survey area, however none of the identified individuals are within the proposed MDE (Maia, 2020a).

6.6.3. Conservation Areas and Environmentally Sensitive Areas

The Proposal is not located within Department of Biodiversity, Conservation and Attractions (DBCA) Legislated Lands and Waters (Maia, 2020a). The closest areas are a Timber Reserve and Weelhamby Lake Nature Reserve, more than 50 km southwest of the MDE.

None of the MDE falls in an area mapped as an Environmentally Sensitive Area (ESA), with the closest being approximately 21 km southeast of the boundary of the MDE (Maia, 2020a). However, the area covered by vegetation within 50 m of a rare/threatened flora, to the extent to which the vegetation is continuous with the vegetation in which threatened flora is located, is an ESA (Maia, 2020a).

The MDE does not lie within or close to a federally listed Threatened Ecological Community (TEC) and no TECs protected by the BC Act are currently known to occur in the Yalgoo bioregion (Maia, 2020a).

The MDE does not intersect the ‘Minjar and Chulaar Hills vegetation complexes (banded ironstone formation)’ Priority 1 (P1) Priority Ecological Community (PEC) that is mapped across some of the Golden Grove Mine tenements.

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Species Name	Abundance in PPB	Abundence in DE
Stylidium scintillans	310	0

499,000 500,000 501,000 502,000 503,000

6,814,000 6,813,000 6,812,000 6,811,000 6,810,000

Data source: Roads - Landgate, 2023. Imagery: ESRI, 2023.

LEGEND

- Prescribed Premises Boundary
- Disturbance Envelope

Threatened and Priority Flora (Maia Environmental Consultancy)

Threatened

- Stylidium scintillans

Western Australian Roads

- Minor Road
- Other

LOCALITY

Mount Magnet
Geraldton
Perth

0 100 200 300 400 500 km

TARGETED THREATENED FLORA SURVEY

Golden Grove
Gossan Valley Mine Site

Works Approval

29Metals

0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:18,000

Prepared:	E Jackson	Date:	14/02/2024
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

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29 Metals Golden Grove

Figure 6-7

6.7 Terrestrial Fauna

6.7.1 Survey Effort

Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by 29Metals to undertake a desktop review and a Level 1 single phase terrestrial fauna survey including targeted Malleefowl, *Egernia stokesii badia* and *Idiosoma clypeatum* searches in 2019 (Error! Reference source not found.**C**).

The field survey area was 806.3 ha and covered portions of three of the GVP tenements (M59/91, M59/92 and M59/93).

Survey Results – Fauna

- A total of 67 terrestrial vertebrate species representing 41 families and 51 genera were recorded in the survey area;
- Of the species observed, 63 were native and four were introduced species;
- Nine mammals were recorded, 45 birds, 13 reptiles and no amphibians; and
- One significant vertebrate fauna species was recorded, Malleefowl, listed as Vulnerable under the EPBC Act and BC Act.

6.7.2 Fauna Habitats

Three broad fauna habitat types were identified in the study area by Phoenix (2020):

- Shrubland on undulating plain (SUP) (739.3 ha, 91.7%);
- Woodland on plain (WP) (24.4 ha, 3.0%); and
- Shrubland on stony hills/breakaway (SBR) (24.5 ha, 3.0%).

The remainder of the area (17.8 ha) was classified as bare ground, completely degraded.

Shrubland on undulating plain was the predominant habitat type within the survey area and largely matches the vegetation association T9. No habitat was considered locally or regionally important (Phoenix, 2020).

Each fauna habitat type in the study area is described in **Table 6-3** below.

The suitability for habitat to support Malleefowl was assessed at 36 locations within the survey area, with habitat found to be suitable to support the species in 20 of these areas (Phoenix 2020).

Table 6-3: Extent and description of each fauna habitat in the study area (Phoenix, 2020)

Habitat Type	Description	Extent of survey area (ha)
Shrubland and undulating plain (SUP)	Isolated Mulga low trees over shrubland of *Acacia* spp., *Eremophila* spp., mixed Myrtaceae and other shrub species over sparse herb on red-orange sandy loams, with patchy leaf litter under shrubs.	739.3
Woodland on plain (WP)	Mallee woodland over mixed *Acacia*, *Eremophila* and other shrubs on red-orange sandy loams with patches of abundant, deep leaf litter extending out from under trees. Mallee with well-formed small/medium hollows.	24.4

Habitat Type	Description	Extent of survey area (ha)
Shrubland on stony hills/breakaway (SBR)	Mixed shrubs of *Acacia, Eremophila*, myrtaceae spp. on red-orange rocks with scattered herbs. Leaf litter occasional, under larger shrubs. Spaces and crevices under/between large rocks and exfoliations for reptiles.	24.5

6.7.3 Conservation Significant Fauna

The survey identified the presence of one conservation significant fauna species within the area, *Leipoa ocellata* (Malleefowl), which is listed as Vulnerable under EPBC and BC Acts (**Figure 6-8**) (Phoenix, 2020). Extensive evidence of the presence of the species was recorded in the form of:

- Scats (2 records);
- Tracks (12 records);
- Foraging evidence (6 records); and
- Mounds (11, two of which were previously known).

Four of the records lie within the proposed MDE, two are degraded mounds and the remainder are evidence of foraging (**Figure 6-8**).

Nineteen conservation significant fauna species were identified as potentially occurring within the survey area during the desktop review portion of the survey (Phoenix, 2020). A likelihood of occurrence assessment was conducted on those species not identified during the field survey (18) and determined two may possibly occur and 16 are unlikely to occur (**Table 6-4**). Extensive searches were conducted for two EPBC reptile species, *Ergonia stokesii* subsp. *badia* and *Cyclodomorphus branchialis* within the survey area, however, no evidence of the species was found. The close proximity of the historical records does not allow the species to be conclusively ruled out from occurring within the area.

Table 6-4: Likelihood of occurrence assessment for significant fauna identified in the desktop review

Species	Common Name	Status	Likelihood of occurrence
Reptiles			
Cyclodomorphus branchialis	Grilled Slender Blue-tongue skink	VU (BC Act)	Possible
Egernia stokesii subsp. *badia*	Stoke's Skink	EN/VU (EPBC Act; BC Act)	Possible
Birds			
Actitis hypoleucos	Common Sandpiper	Mig. (EPBC & BC Acts)	Unlikely
Apus pacificus	Fork-tailed Swift	Mig. (EPBC & BC Acts)	Unlikely
Calidris acuminata	Sharp-tailed Sandpiper	Mig. (EPBC & BC Acts)	Unlikely

Species	Common Name	Status	Likelihood of occurrence
Calidris ferruginea	Curlew Sandpiper	CR/Mig./CR (EPBC Act; BC Act)	Unlikely
Calidris melanotos	Pectoral Sandpiper	Mig. (EPBC & BC Acts)	Unlikely
Falco peregrinus	Peregrine Falcon	OS (BC Act)	Unlikely
Ixobrychus dubius	Australian Little Bittern	P4 (DBCA list)	Unlikely
Motacilla cinerea	Grey Wagtail	Mig. (EPBC & BC Acts)	Unlikely
Oxyura australis	Blue-billed Duck	P4 (DBCA list)	Unlikely
Pezoporus flaviventris	Western Ground Parrot	CR (EPBC & BC Acts)	Unlikely
Rostratula australis	Australian Painted Snipe	EN (EPBC & BC Acts)	Unlikely
Tringa nebularia	Common Greenshank	Mig. (EPBC & BC Acts)	Unlikely
Tyto novaehollandiae	Masked Owl (northern)	VU EPBC Act; P1 DBCA List	Unlikely
Tyto novaehollandia subsp. *novahollandiae*	Masked Owl (southwest)	P3 (DBCA List)	Unlikely
Mammals			
Dasyurus geoffroii	Chuditch	VU (EPBC & BC Acts)	Unlikely
Leporillus apicalis	Lesser Stick-nest Rat	EX (EPBC & BC Acts)	Unlikely
Notamacropus irma	Western Brush Wallaby	P4 (DBCA List)	Unlikely

6.7.4 Short Range Endemics

Desktop review identified records of 62 potential SRE texa occurring within the MDE (Phoenix, 2020). However, the field survey did not identify any habitats that were considered prospective for SRE invertebrates. Despite breakways in the Murchison region and other semi-arid areas often being associated with SRES, those in the survey area were poorly vegetated and offered no mesic conditions on which SREs might be found to persist (Phoenix, 2020).

6.8 Subterranean Fauna

AECOM was commissioned to conduct a desktop assessment for subterranean fauna (stygofauna and troglofaunal) for the GVP in 2020. As discussed in **Section 6.3**, the Project area is comprised of metamorphosed Archaean volcanic rocks overlain by alluvium and clays. The alluvium and clay lithologies surrounding and within much of the Project area have a low suitability for both troglofaunal and stygofauna habitat due to the absence of interconnected voids in these fine-grained units (AECOM, 2020c).

Four stygofauna communities, all listed as Priority 1 Ecological Communities (PEC), are known to occur in the local region. These calcretes were listed due to the presence of stygobiontic Dytiscid diving beetles and other stygofauna species that occur in virtually every calcrete in the Yilgarn (AECOM, 2020c). The calcrete PECs also have a high likelihood of containing troglofaunal species, however, these PECs occur at least 20 km away from the Gossan Valley Project footprint and zone of impact (AECOM, 2020c).

A previous survey of the Golden Grove Project area by Biota in 2010 recorded no presence of troglofaunal and a low likelihood for stygofauna due to a lack of suitable habitat, poor water quality and the highly

heterogeneous nature of the aquifer within the nearby Gossan Hill open cut area. It is therefore anticipated that due to the similar geological and hydrological conditions within the GVP area, that troglofaunal and stygofauna are both absent due to an absence of suitable habitat and no impacts to subterranean fauna will occur from the development of the GVP (AECOM, 2020c).

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Mound ID	Species Name	Mound Type	Number of Individuals Recorded	Number of Individuals in DE
GGGT7SP	Malleefowl	Mound - degraded	1	0
GGGMF05	Malleefowl	Mound - degraded	0	0
GGGMF11	Malleefowl	Mound - degraded	0	0
GGGMF12	Malleefowl	Mound - degraded	0	0
JS199	Malleefowl	Mound - degraded	0	0

GGGMF12
GGGMF11
GGGMF05
GGGT7SP
JS199

Data source: Roads - Landgate, 2023. Imagery: ESRI, 2023.

LEGEND

Prescribed Premises Boundary

Malleefowl Survey Points

Mound - Degraded

Western Australian Roads

Minor Road

Other

LOCALITY

Mount Magnet
Geraldton
Perth

0 100 200 300 400 500 km

FAUNA

Golden Grove
Gossan Valley Mine Site

Works Approval

29Metals

0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:18,000

Prepared:	E Jackson	Date:	14/02/2024
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

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29 Metals Golden Grove

Figure 6-8

7. Assessment of Impacts

7.1. Receptors

There are no proximal sensitive receptors that operations at the GVP pose an impact to. In terms of the broader suite of potential receptors, these include native vegetation, fauna and water resources, and are discussed in detail in the below sections.

7.2. Air Quality

As there are no nearby sensitive receptors, the effects of construction of the proposed works on the local or regional air quality are not anticipated to be significant. Ground disturbance operations have the potential to generate dust and noise if they are not properly managed, however these emissions are localized and transient. To prevent operating in windy conditions, extra controls and careful activity scheduling are needed. Controlling these emissions will be done using standard dust-control procedures. If necessary, reporting of emissions will be undertaken in accordance with the *National Greenhouse and Energy Reporting Act 2007 (NGER Act)* and National Pollutant Inventory Reporting.

Fugitive dust may be generated during the construction and operation of the proposed works, in particular:

- During earthworks; and
- During the movement of vehicles and equipment across the proposed Premises.

The construction of the supporting infrastructure will be undertaken over short period of time, and as such, the amount of dust generated during this time is expected to be minimal and time limited. There are no sensitive receptors within the proposed Premises so it is anticipated that these activities will have minimal effects. Additional mitigation steps will be performed to lessen any potential impact (**Section 8**).

The proposed works are unlikely to significantly increase dust related impacts to the environment, with all potential impacts able to be managed through controls detailed in existing site Management Plans and other approval instruments. These instruments include the Gossan Valley Mining Proposal (draft) and Golden Grove site Operating Licence L8593/2011/2.

7.3. Noise

It is not anticipated that noise from equipment used in the construction of the proposed works will surpass typical Occupational Health and Safety Standards. To guarantee that noise is kept to a minimum, all machinery and equipment will be maintained in accordance with manufacturer's guidelines. Regular inspections and maintenance will be conducted to identify and address any potential sources of excessive noise. Additionally, employees will be provided with appropriate personal protective equipment to further mitigate the impact of noise on their health and safety.

Given there are no nearby sensitive receptors, the GGO is anticipated to be in compliance with the *Environmental Protection (Noise) Regulations 1997*.

7.4. Soils

No significant impacts to soils are anticipated as a result of the proposed works.

The potential for leaching of contaminants from waste material disposed of in the landfill is minimal as a Class I landfill, with only inert type I waste approved for disposal. Hydrocarbon spill may occur during the operation of the plant to construct the trench. Spills of this nature are most likely to originate from a burst hydraulic hose. Only a single excavator is required for the works and only for a period of 4 months, reducing the risk of this type of spill. Any spills that do occur will be managed in accordance with existing Golden Grove spill management procedures.

There is the potential for small spills and leaks to occur from the proposed dewatering infrastructure during the commissioning and operation phases. Leaks from pipelines or bores will have a negligible impact on soils from a salinity perspective as groundwater quality for the site is not considered to be saline (averaging around 2,000 mg/L TDS) (AECOM, 2020). Management measures to reduce the likelihood of leaks and spills occurring are detailed in **Section 8**.

7.5. Water Resources

Dewatering activities facilitated by the construction of the proposed infrastructure in this WA application have the potential to impact groundwater resources through drawdown related impacts and impacts to water quality. Excess dewatering water is also proposed to be disposed of at Lake Wownaminya (the Lake), and introduction of groundwater from the GV aquifer may alter the water chemistry of water discharged to the lake and the resulting water quality in the Lake.

AECOM was commissioned in 2020 to conduct an assessment of the potential impacts of dewatering activities at the GVP on the surrounding environment.

Drawdown in the fractured bedrock aquifer resulting from dewatering abstraction as modelled (AECOM, 2020) indicates under likely conditions, drawdown is predicted to extend 1.8 km to the west (within the GV catchment), 2.4 km to the northwest (towards Gossan Hill) and 2.8 km to the southeast. Under worst-case conditions, drawdown is predicted to extend 2 km to the west (within the GV catchment), 2.6 km to the northwest (towards Gossan Hill) and 3 km to the southeast (AECOM, 2020).

There are no known ecological receptors (including vegetation and subterranean fauna) that are dependent on groundwater in the GVP area (AECOM, 2020). Drawdown-related risks to ecological receptors are therefore considered to be very low (AECOM, 2020).

Significant drawdown (>5 m) is only predicted to extend within the GV catchment. The closest part of the Minjar Gold Operations is located approximately 3.2 km to the west of Gnows Nest Range (7.6 km in total). Given the distance and shorter mine life of the GVP, significant drawdown is unlikely to propagate to Gnows Nest Range, or the extra 3.2 km to the Minjar Gold Operations further to the west (AECOM, 2020).

None of the wells and bores on the former Warriedar and Thunderlarra stations and de-stocked Muralgarra Station are active.

Drawdown related risks to existing groundwater users are therefore considered to be very low.

Based on the observed values and trends, mine dewatering at GV is likely to (AECOM, 2020):

- Increase the salinity with time after shallower groundwater has been removed leaving deeper more saline groundwater but not to a point that it will exceed the current licence limits;
- Increase sulphate concentrations relative to chloride due to sulphide oxidation in the fractured bedrock aquifer and follow a long-term trend similar to Gossan Hill or Scuddles;
- Increase calcium/magnesium concentrations relative to sodium/potassium due to the prevalence of dolerite in the saprock aquifer, similar to the trends observed at GGW67P and GGW69P; and
- Have a pH in a near-neutral to weakly alkaline range similar to the Gossan Hill and Scuddles mines.

Based on monitoring data from the past 25 years from underground mine discharges, groundwater bore abstraction and lake discharges, incorporating groundwater from GV into the Golden Grove mine water system is not expected to pose a significant exceedance risk to the Lake Wownaminya discharge limits specified in Licence L8593/2011/2 (AECOM, 2020).

7.6. Flora and Vegetation

Potential impacts to vegetation will arise from any clearing works required as part of the construction of the proposed works. Potential impacts identified include:

- Potential risks associated with increase in abundance and spread of weeds affecting both native flora and fauna;
- Potential clearing and other disturbance to Threatened flora species *Stylidium scintillans* (under the BC Act);
- Potential clearing and other disturbance to Priority 3 flora species *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096), *Drummondita fulva, Grevillea globose* and *Micromyrtus trudgenii*; and

- Clearing and disturbance associated risks on a P1 Priority Ecological Community (PEC) 'Minjar and Chulaar Hills vegetation complexes (Banded Ironstone Formation).

A Native Vegetation Clearing (purpose) Permit has been submitted and approved for the GVP. Potential impacts to native vegetation will be managed under the approved permit CPS 9046/1.

7.7. Fauna

No significant impacts to fauna are expected as a result of the proposed works, however clearing of habitat as well as impacts during construction from noise, light and dust emissions may result in minor impacts through behaviour changes. The fauna habitat types in the area are extensively represented, enabling migration and reducing the level of impact resulting from the proposed clearing.

Additional impacts may include fauna entrapment within containment infrastructure, as well as injury or mortality from vehicle strike.

8. Management of Impacts

The proposed controls to manage the potential impacts associated with the proposed works are outlined Table below. A map of the emission points is provided in **Figure 8-1.**

Table 8-1: Management Measures for Potential Impacts

Sources	Emissions	Potential Pathways	Mitigation Measures
Earthworks and vehicle movements	Dust	Air/windborne pathway	• Land disturbance will be kept to the minimum necessary for development of the project within the Premises; • Water cart dust suppression, with increased suppression in windy conditions; • Earth works stopped during high winds; • Vehicle traffic confined to designated roads and tracks; • Occupational hygiene requirements for dust will be complied with in operational areas.
Earthworks and vehicle movements	Noise	Noise disruption to native fauna	• Maintain equipment and vehicles in accordance with manufacturer recommendations; • All equipment used on site will comply with Australian Standards for noise; and • Noise managed through Air Noise Vibration Management Plan.
Dewatering pipelines	Dewatering effluent	Leakage/failure of pipeline	• Pipelines laid within existing roadside drains; • Remote monitoring of pipelines via installed telemetry, and • Weekly in-field inspections of pipelines.
Dewatering dams	Dewatering effluent	Direct discharge due to over topping of dam wall	• In situ telemetry providing continuous monitoring of freeboard level; • Daily inspection of dams to ensure specified freeboards are maintained; and • Ability to pump excess water to the Gossan Hill mill to prevent overflows.

Sources	Emissions	Potential Pathways	Mitigation Measures
Gossan Valley groundwater	Dewatering effluent of differing hydrochemistry to Gossan Hill and Scuddles	Discharge to Lake Wownaminya	• Groundwater quality assessment conducted (Appendix A); • Prioritize re-use of water at GV underground to reduce volume of excess water sent to the Gossan Hill mill; and • Monitoring of discharge water quality as per existing Licence L8593/2011/2 conditions
Site waste (construction/operations)	Inert Waste Type 1	As produced, to landfill	• Base of landfill trench minimum 3 m above groundwater level; • Wind bund installed to prevent incidence of windblown waste leaving landfill footprint; and • Progressive covering of waste with waste rock.

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LAKE WOWNAMINYA

HAMMENS POOL

MONGERS LAKE

Waste Rock Dump

Batch Plant

Topsoil Stockpile

Landfill

Boxcut

Rise

Power Plant

Powerline

Data source: Lakes - Geoscience Australia, 2024. Imagery: ESRI, 2023.

LEGEND

- Prescribed Premises Boundary (Gossan Valley)
- Prescribed Premises Boundary (Golden Grove)

Emission Points

- Emission Point 1: Landfill
- Emission Point 2: Lake Wownaminya

Site Disturbance

- Lake Wownaminya Pipeline
- Proposed Disturbance Footprint (Gossan Valley)
- Existing Disturbance Footprint (Golden Grove)

Hydrology

- Lakes

LOCALITY

Mount Magnet

Geraldton

Perth

0 100 200 300 400 500 km

EMISSION POINTS

Golden Grove
Gossan Valley Mine Site

Works Approval

29Metals

0 2 4 6 8 km

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:180,000

Prepared:	E Jackson	Date:	14/02/2024
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

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Figure 8-1

9. References

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10. Appendices

10.1. Appendix A Gossan Valley Project Groundwater Assessment (AECOM, 2020)

10.2. Appendix B Detailed Flora and Vegetation Assessment (Maia, 2020)

10.3. Appendix C Terrestrial Fauna Survey (Phoenix, 2020)

10.4. Appendix D Stakeholder Engagement Register

10.5. Appendix E Construction costings for prescribed premise categories

10.6. Appendix F Non-Mineral Waste Management Plan

10.7. Appendix G Landfill schematic

10.8. Appendix H Isometric and Sectional views of Landfill